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(72) Inventor: **Abe, Kazuhiro**
Minato-ku, Tokyo 106-8510 (JP)

(74) Representative:
Banzer, Hans-Jörg, Dipl.-Ing. et al
Kraus & Weisert
Patent- und Rechtsanwälte
Thomas-Wimmer-Ring 15
80539 München (DE)

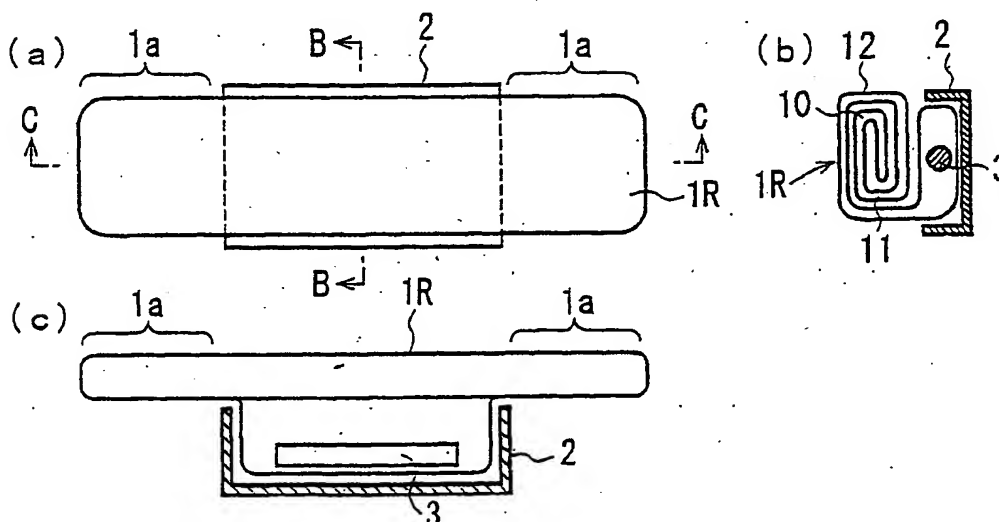
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(71) Applicant: **TAKATA CORPORATION**
Minato-ku, Tokyo 106-8510 (JP)

(54) Passenger leg protection apparatus

(57) The object is to provide a passenger leg protection apparatus that is inflated smoothly being rarely blocked by the legs of the passenger. An airbag (1) is folded along lateral folding lines to form a main wound body (1R), and then overhanging portions (1a) of the airbag (1) overhanging leftward and rightward from a

case (2) are folded along vertical folding lines to form side wound bodies (1r). Subsequently, the wound bodies (1R), (1r) are stored into the case (2), and a lid (4) is attached thereon. In another embodiment, the main wound body (1R) is formed by first folding said airbag along the vertical folding lines, and then folding along the lateral folding lines.

Fig. 4**EP 1 336 537 A2****Best Available Copy**

Description**[Technical Field of the Invention]**

[0001] The present invention relates to a passenger leg protection apparatus, and, more specifically, to an apparatus for protecting legs of a passenger on a high-speed traveling body such as an vehicle by inflating an airbag so-called kneebag or knee-airbag at the position forwardly of the legs in case of collision of the vehicle or the like.

[Description of the Related Art]

[0002] A passenger leg protection apparatus in which an airbag device is installed in the interior member in front of the seat of the motor vehicle about the level that corresponds to the lower legs of the passenger and the airbag is inflated upon collision of the vehicle to receive the legs, especially, the portions under the knees, of the passenger, is already known. This passenger leg protection apparatus includes a folded airbag, a case for accommodating the airbag, a gas generator for inflating the airbag, and a lid member for covering the front face of the case or the like.

[Problems to be Solved by the Invention]

[0003] A method of folding the airbag of the passenger leg protection apparatus is not practically announced. Only a method of folding the airbag for expanding and deploying the airbag sideways quickly is described in Japanese Unexamined Patent Application Publication No.5-208648. However, the passenger leg protection apparatus in this publication is of a type in which the position of installation is shifted leftward or rightward from the front of the legs of the passenger.

[0004] Accordingly, it is an object of the present invention to provide a passenger leg protection apparatus to be disposed in front of the legs of the passenger in which the airbag is deployed smoothly upward or downward along the legs of the passenger.

[Means for Solving the Problems]

[0005] According to the present invention, this object is achieved by a passenger leg protection apparatus as defined in claim 1. The dependent claims define advantageous and preferred embodiments of the present invention.

[0006] The passenger leg protection apparatus according to the present invention includes an airbag to be inflated at the position in front of the legs of the passenger for protecting the legs, a case accommodating the folded airbag, and a gas generating unit for inflating the airbag, wherein the folded body of the airbag includes a wound body formed by being folded along the lateral folding lines extending laterally of the passenger

a plurality of times in the same folding direction, and the airbag is disposed in the case so that the wound body is deployed upward or downward while rolling along the front surface of the legs so as to be unwound when being inflated.

[0007] In the passenger leg protection apparatus of the present invention, the gas generating unit is actuated in case of emergency such as collision of the vehicle or the like to inflate the airbag to receive the legs of the passenger.

[0008] The folded body of the airbag includes a wound body formed by being folded and wound along the lateral folding lines a plurality of times in the direction toward or away from the passenger. When the airbag is inflated, the wound body is deployed while being rotated upward or downward along the front surface of the legs of the passenger. Therefore, the airbag is capable of being inflated smoothly upward or downward being rarely blocked by the front surface of the legs of the passenger.

[0009] In an embodiment of the present invention, after the aforementioned wound body is formed, the airbag is folded along the lateral folding lines extending laterally of the passenger a plurality of times in the direction toward or away from the passenger, and then folded along the vertical folding lines extending vertically of the passenger. In this mode, after coming out of the case, the airbag is deployed in the lateral direction and placed in front of the left leg and the right leg of the passenger, and subsequently is inflated while being rotated upward or downward. This mode is especially preferable when a space available in front of the passenger is relatively large.

[0010] In another embodiment of the present invention, the wound body of the airbag is formed by being folded along the vertical folding lines in a first place, and then folded along the lateral folding lines. In this mode, after coming out of the case, the airbag is deployed from the left and right folded portions, and almost simultaneously, the wound body is inflated while rolling upward or downward. This mode is especially preferable when a space available in front of the legs of the passenger is relatively small.

[Brief Description of the Drawings]

[0011] Fig. 1 shows a procedure of folding an airbag according to an embodiment of the invention.

[0012] Fig. 2 shows a procedure of folding the airbag according to an embodiment of the invention.

[0013] Fig. 3 shows a procedure of folding the airbag according to an embodiment of the invention.

[0014] Fig. 4 shows a procedure of folding the airbag according to an embodiment of the invention.

[0015] Fig. 5 shows a procedure of folding the airbag according to an embodiment of the invention.

[0016] Fig. 6 shows a procedure of folding the airbag according to an embodiment of the invention.

[0017] Fig. 7 shows a procedure of folding the airbag

according to an embodiment.

[0018] Fig. 8 shows a procedure of folding the airbag according to an embodiment of the invention.

[0019] Fig. 9 shows a procedure of folding the airbag according to an embodiment of the invention.

[0020] Fig. 10 shows a procedure of folding the airbag according to an embodiment of the invention.

[0021] Fig. 11 shows a procedure of folding the airbag according to an embodiment of the invention.

[0022] Fig. 12 shows a procedure of folding the airbag according to an embodiment of the invention.

[0023] Fig. 13 shows a procedure of folding the airbag according to an embodiment of the invention.

[0024] Fig. 14 shows a procedure of folding the airbag according to an embodiment of the invention.

[0025] Fig. 15 shows a procedure of folding the airbag according to an embodiment of the invention.

[0026] Fig. 16 shows a procedure of folding the airbag according to an embodiment of the invention.

[0027] Fig. 17 shows a procedure of folding the airbag according to an embodiment of the invention.

[0028] Fig. 18 shows a procedure of folding the airbag according to an embodiment of the invention.

[0029] Fig. 19 shows an explanatory drawing showing a state of inflation of an airbag according to still another embodiment of the invention.

[Description of Embodiments]

[0030] Referring now to the drawings, embodiments of the present invention will be described.

[0031] Fig. 1 to Fig. 5 are explanatory drawings illustrating an airbag folding procedure in the passenger leg protection apparatus according to an embodiment, in which the figures marked as (b) in the respective figures are cross sections taken along the line B-B in the figures marked as (a) in the respective figures, Fig. 4(c) is a cross section taken along the line C-C in Fig. 4(a). Figs. 6(a), (b) and (c) are explanatory drawings illustrating steps of inflation of this airbag.

[0032] This passenger leg protection apparatus includes an airbag (knee-airbag) 1, a case 2 accommodating the folded airbag 1, an inflator 3, which corresponds to a gas generator, for inflating the airbag 1, and a lid 4 (See Fig. 5) for covering the front opening of the case 2. The inflator 3 is disposed in the airbag 1. A stud bolt (not shown) is projected from the inflator 3 or a holder (not shown) holding the inflator 3, and the stud bolt passes through the airbag 1 and the rear surface of the case 2, and a nut (not shown) is tightened thereon. Such tightening of the nut fixes the inflator 3 to the case 2, and the rear end of the airbag 1 is clamped between the inflator 3 or the holder thereof and the rear surface of the case 2.

[0033] The folding procedure of the airbag 1 is as follows. The airbag 1 is placed on a flat and horizontal working table together with the case 2, spread flatly, and then folded. However, the airbag 1 is shown in a state

of being spread along the vertical plane in Fig. 1 to Fig. 3, in order to make description based on the state in which the passenger leg protection apparatus is mounted on a vehicle. In Figs. 1 to 3, Figs. 4(a) and (b), Fig. 5(b) and Fig. 6, the vertical directions in the respective figures corresponds substantially to the vertical direction of the passenger leg protecting apparatus being mounted on the vehicle.

[0034] The airbag 1 is pulled out from the case 2 as shown in Fig. 1, and spread flatly. In this embodiment, the airbag 1 is spread upwardly of the case 2. Subsequently, as shown in Fig. 2, the airbag 1 is folded along a lateral folding line 10 at the position of the airbag a predetermined width (for example, 20 to 150 mm) away from the upper edge 1t in the direction from the passenger side 1j to the opposite side 1h from the passenger.

[0035] Subsequently, as shown in Fig. 3, the airbag 1 is folded along a lateral folding line 11 at the position almost the same width below the aforementioned folding line 10 from the passenger side 1j to the opposite side 1h from the passenger. Then, as shown in Fig. 4, the airbag 1 is folded again along a lateral folding line 12 at the position almost the same width below the aforementioned folding line 12 from the passenger side 1j to the opposite side 1h from the passenger. The folding direction along the folding lines 11, 12 and 13 are the same direction, whereby, a wound body (main wound body) 1R is formed as shown in Fig. 4(b). The wound body 1R is wound clockwise toward the edge 1t as shown in vertical cross section taken along plane extending in the fore-and-aft direction of the vehicle in a state in which the passenger is placed on the left side in the figure.

[0036] The wound body 1R includes overhanging portions 1a overhanging leftward and rightward from the case 2, as shown in Fig. 4(a) and (c). Accordingly, these overhanging portions 1a are folded along vertical folding lines 15, 16 (See Fig. 5(a)) toward the inside of the case 2 from the passenger side 1j to the side 1h opposite from the passenger to form wound bodies (side wound bodies) 1r, and then stored in the case 2. Subsequently, the lid 4 is attached to complete the passenger leg protection apparatus.

[0037] The passenger leg protection apparatus is installed, for example, in the interior panel in front of the seat, and the lid 4 is disposed to be flush with the interior panel.

[0038] When the inflator 3 is actuated and the airbag 1 of the passenger leg protection apparatus is inflated upon collision of the vehicle, the lid 4 is opened by being pressed by the airbag 1, and the side wound bodies 1r of the airbag 1 projects from the case 2 toward the front as shown in Fig. 6(a). Subsequently, the side wound bodies 1r are deployed leftward and rightward of the legs of the passenger, as shown in Fig. 6(b), and then the main wound body 1R of the airbag 1 is deployed upward in front of the legs of the passenger. The main wound body 1R wound in the clockwise direction rotates

in the counterclockwise direction θ as shown in Fig. 6 (c), and is deployed upward. In this case, since the wound bodies 1r and 1R are unwound so as to be rolled along the front surface of the legs, the airbag 1 is rarely blocked by the front surface of the legs upon inflation. Therefore, the airbag 1 deploys quite smoothly.

[0039] Referring now to Fig. 7 to Fig. 10, another folding procedure will be described. The figures marked as (b) in Fig. 7 to Fig. 9 are cross sections taken along the line B-B in the figures marked as (a) in the respective figures.

[0040] Figs. 7(a) and (b) show states in which the airbag is flatly spread as in Figs. 1(a) and (b) before being folded. The airbag 1 is spread upward of the case 2.

[0041] From this state, as shown in Figs. 7(c) and (d) (Fig. 7(d) is a cross section taken along the line D-D in Fig. 7(c)), the airbag 1 is folded downwardly of the case 2 as a whole along a lateral folding line 21. Subsequently, as shown in Figs. 8(a) and (b) and Fig. 9(a) and (b), the airbag 1 is folded along lateral folding lines 22, 23, 24 in sequence to form a main wound body 1R'. The wound body 1R' is also wound in the clockwise direction toward the edge 1t as shown in a vertical cross sectional view shown in Fig. 9(b).

[0042] Subsequently, side wound bodies 1r' as shown in Figs. 10(a) and (b) are formed by folding or winding the left and right overhanging portions 1a overhanging from the case 2 along the vertical folding lines in the same direction, then the wound bodies 1r' and 1R' are stored inside the case 2, and the lid 4 (not shown in Fig. 10(a)) is attached to complete the passenger leg protection apparatus.

[0043] The sequence of inflation of the airbag 1 of the passenger leg protection apparatus is the same as that shown in Fig. 6. In other words, in this case as well, the airbag 1 comes out from the case 2 toward the front, deployed leftward and rightward quickly as if it rolls while being rarely blocked by the legs of the passenger and then deployed upward smoothly.

[0044] Referring now to Fig. 11 to Fig. 13, still another folding procedure will be described. Figs. 11(b), (c) and (d) are cross sectional view taken along the lines B-B, C-C and D-D in Fig. 11(a), Fig. 12(b) is a cross sectional view taken along the line B-B in Fig. 12(a), and Figs. 13 (b), (d) and (f) are cross sectional views taken along the lines B-B, D-D and F-F in Figs. 13(a), (c) and (e).

[0045] In a first place, the airbag 1 is folded along a lateral folding line 30 so that the airbag 1 is placed downwardly of the case 2 as a whole as shown in Figs. 11(a) and (b). The state before folding along folding lines 31 that will be described later is the same as Figs. 7(c) and (d).

[0046] From the state shown in Fig. 7(c) and (d), the airbag 1 is folded along the oblique folding lines 31 at the corners near both ends of the edge 1t of the airbag toward the passenger. The folding lines 31 intersect both of the edge 1t and side edges of the airbag, which meet at the corners thereof.

[0047] As shown in Figs. 12(a) and (b) and Figs. 13 (a) and (b), the airbag 1 is further folded along the second folding lines 32 and 33 in parallel with the folding lines 31 twice toward the passenger.

[0048] Subsequently, as shown in Figs. 13(c) and (d), the lower portion of the airbag 1 is folded along a lateral folding line 34 so that the edge 1t is placed on the passenger side. Then, as shown in Figs. 13(e) and (f), the airbag 1 is folded along lateral folding lines 35 and 36 to form a main wound body 1R". The wound body 1R" is wound clockwise toward the edge 1t as shown in Fig. 13(f).

[0049] As shown in Fig. 13(e), the wound body 1R" has left and right overhanging portions 1a, though it is not shown, these overhanging portions 1a are wound as in Fig. 5 to form the side wound bodies, and then stored in the case 2. Subsequently, the lid is attached to complete the passenger leg protection apparatus.

[0050] According to the passenger leg protection apparatus, the same effects as in the aforesaid passenger leg protection apparatus are achieved. In the embodiment shown in Fig. 11 to Fig. 13, since there are portions folded along the oblique folding lines 31, 32 and 33, the inflation of the left and right corner portions of the airbag 1 is delayed, and as a consequence, deployment of the airbag 1 in the lateral direction and upward direction is achieved sooner correspondingly.

[0051] Referring now to Fig. 14, further another airbag folding procedure will be described. Fig. 14(b) is a cross section taken along the line B-B in Fig. 14(a), and Figs. 14 (d), (e) are cross sections taken along the line D-D, E-E in Fig. 14(c).

[0052] In the procedure shown in Fig. 14, the airbag 1 is set to the initial state shown in Figs. 1(a) and (b), and then the upper portion of the airbag 1 is folded along a lateral folding lines 41, 42 and 43 into concertinas. Subsequently, as shown by an arrow A, the portions of concertinas are folded along a lateral folding line 44 so as to roll up inwardly. As shown in Fig. 14(d), a main wound body rolled counterclockwise from the lateral folding line 43 to the lateral folding line 44 is formed. The left and right overhanging portions 1a of this wound body are wound to form side wound bodies, and stored inside the case 2. Subsequently, the lid is attached to complete the passenger leg protection apparatus.

[0053] This type of passenger leg protection apparatus has the same effects as the preceding embodiments. Especially, in this type of passenger leg protection apparatus, in the last stage of inflation is nearly finished, the portion of concertinas is inflated so as to extend upward. Since the area that the portion of concertinas extends is located upwardly of the patella, it is not brought into friction with legs of the passenger.

[0054] As shown in Fig. 15, the portion near the edge 1t of the portion of concertinas shown in Fig. 14(b) may further be folded along the lateral folding line 40.

[0055] Referring now to Fig. 16 and Fig. 17, further

different embodiment will be described. Figs. 16(c) and (d) are cross sections taken along the line C-C and D-D in Fig. 16(b).

[0056] In this embodiment, the airbag 1 is folded from the initial state (the same as Fig. 1(a) described above) of Fig. 16(a) in such a manner that both side portions 1b along both sides 1c of the airbag 1 is pushed into the airbag 1 along vertical folding lines 50 as shown in Figs. 16(b), (c) and (d). Subsequently, wound bodies are formed by folding along the lateral folding lines 51, 52 and 53 according to the procedure shown in Figs. 2, 3 and 4 as shown in Figs. 17(a), (b) and (c). Then, as shown in Fig. 17(d), the folded body is stored into the case 2 as shown by an arrow P, and a lid is attached thereon to complete the passenger leg protection apparatus.

[0057] When the passenger leg protection apparatus of this embodiment is inflated, the airbag 1 comes out from the case 2 once, and then the wound body is inflated as it rolls upward along the legs of the passenger. Subsequently, side portions 1c are inflated laterally to the end. In this manner, since the airbag 1 is inflated upward in an early state, this embodiment is preferable for a small vehicle in which only a small space is available around the patella of the passenger.

[0058] As shown in Figs. 18(a) and (b), the airbag 1 may also be folded from the initial state shown in Fig. 1 in such a manner that the upper edge 1t is pushed into the airbag 1 along a lateral folding line 60, and then folded according to any one of the folding procedures described above. In Figs. 18(c) and (d), after the procedure shown in Figs. 18(a) and (b), the airbag 1 is folded along lateral folding lines 61, 62 and 63 to form a main wound body according to the procedure shown in Fig. 2 to Fig. 4, and then is folded along the lateral folding lines 61, 62 and 63 to form a main wound body. Subsequently, the overhanging portions 1a are wound to form the side wound bodies, stored inside the case 2 to complete the passenger leg protection apparatus.

[0059] Fig. 18(b) is a cross section taken along the line B-B in Fig. 18(a), and Fig. 18(d) is a cross section taken along the line D-D in Fig. 18(c).

[0060] In the present embodiment, the main wound body is inflated as if it rolls upward from the bottom, but it may be folded so that the airbag is inflated as if it rolls downward from the top along the front surface of the legs of the passenger according to the present invention as shown in Fig. 19. In this case, the airbag is to be folded in vertical mirror opposite from the preceding embodiments.

[Advantages]

[0061] As described thus far, the passenger leg protection apparatus of the invention is inflated smoothly being rarely blocked by the legs of the passenger.

Claims

1. A passenger leg protection apparatus comprising:
 - an airbag (1) to be inflated at a position in front of legs of a passenger for protecting the legs;
 - a case (2) accommodating the folded airbag (1); and
 - a gas generating unit (3) for inflating the airbag, wherein a folded body of the airbag (1) includes a wound body (1R) formed by being folded along lateral folding lines (10-12) extending laterally of the passenger a plurality of times in the same folding direction, and the airbag (1) is disposed in the case (2) so that the wound body (1R) is deployed upward or downward while rolling along the front surface of the legs so as to be unwound when being inflated.
2. A passenger leg protection apparatus according to Claim 1, said airbag (1) is folded along the lateral folding lines (10-12) to form said round body (1R), and then folded along vertical folding lines (15, 16) extending vertically of the passenger.
3. A passenger leg protection apparatus according to Claim 1, wherein said wound body is formed by folding said airbag along the vertical folding line (50), and then folding along the lateral folding lines (51-53).

Fig. 1

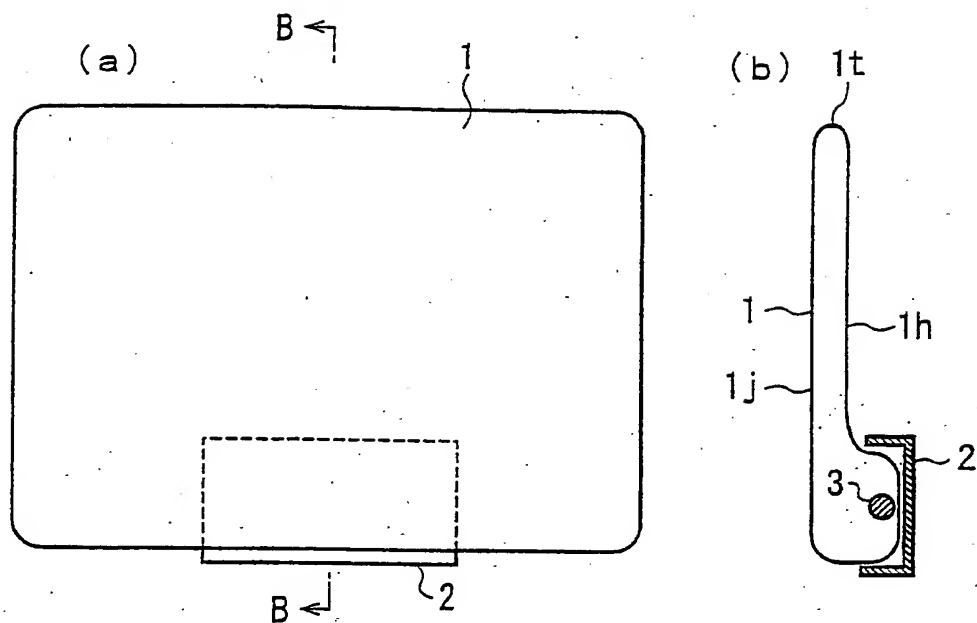


Fig. 2

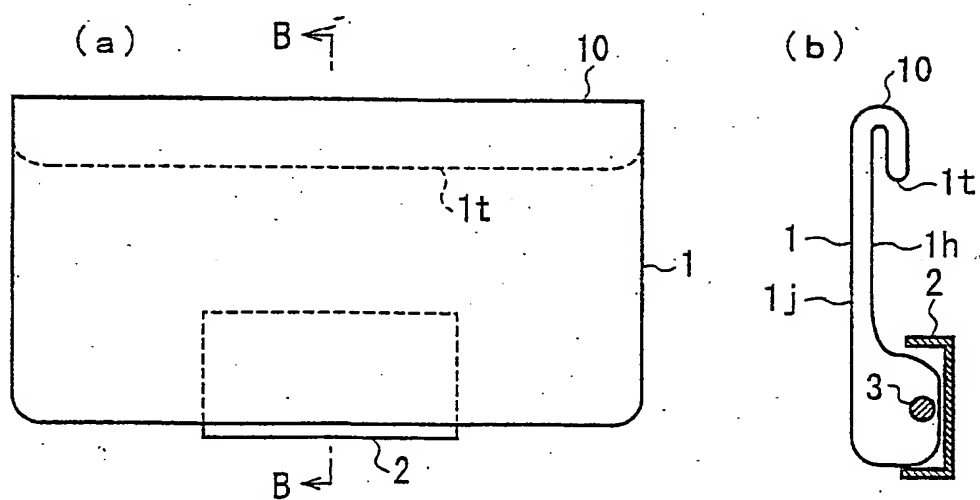


Fig. 3

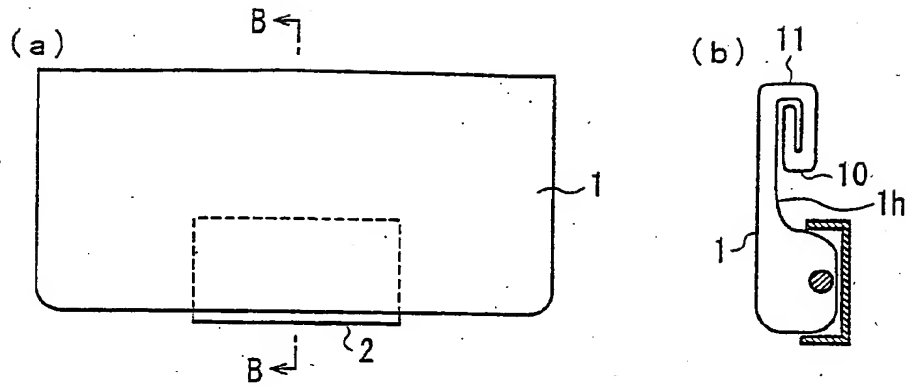


Fig. 4

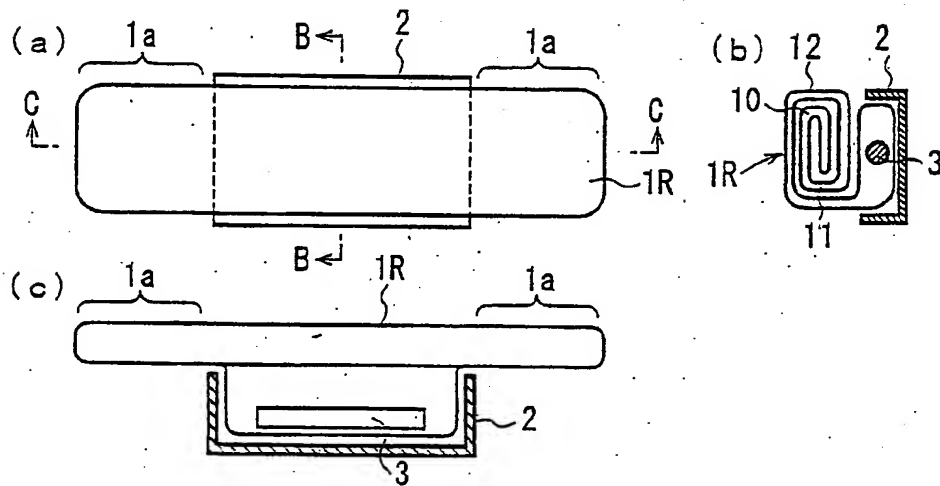


Fig. 5

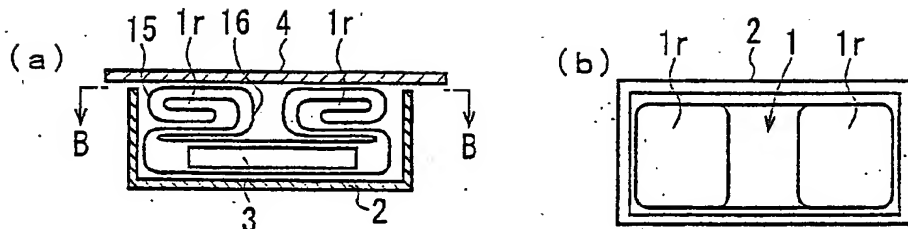


Fig. 6

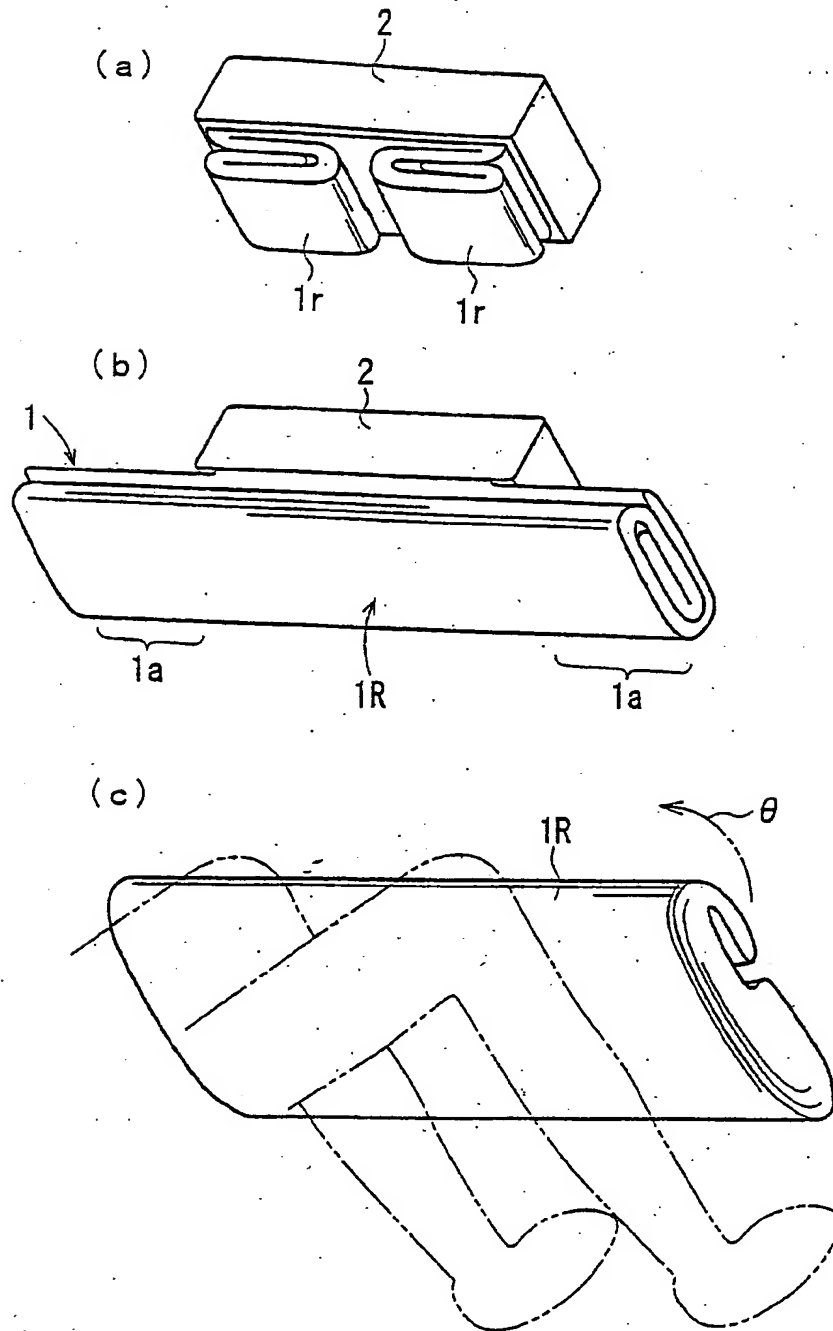


Fig. 7

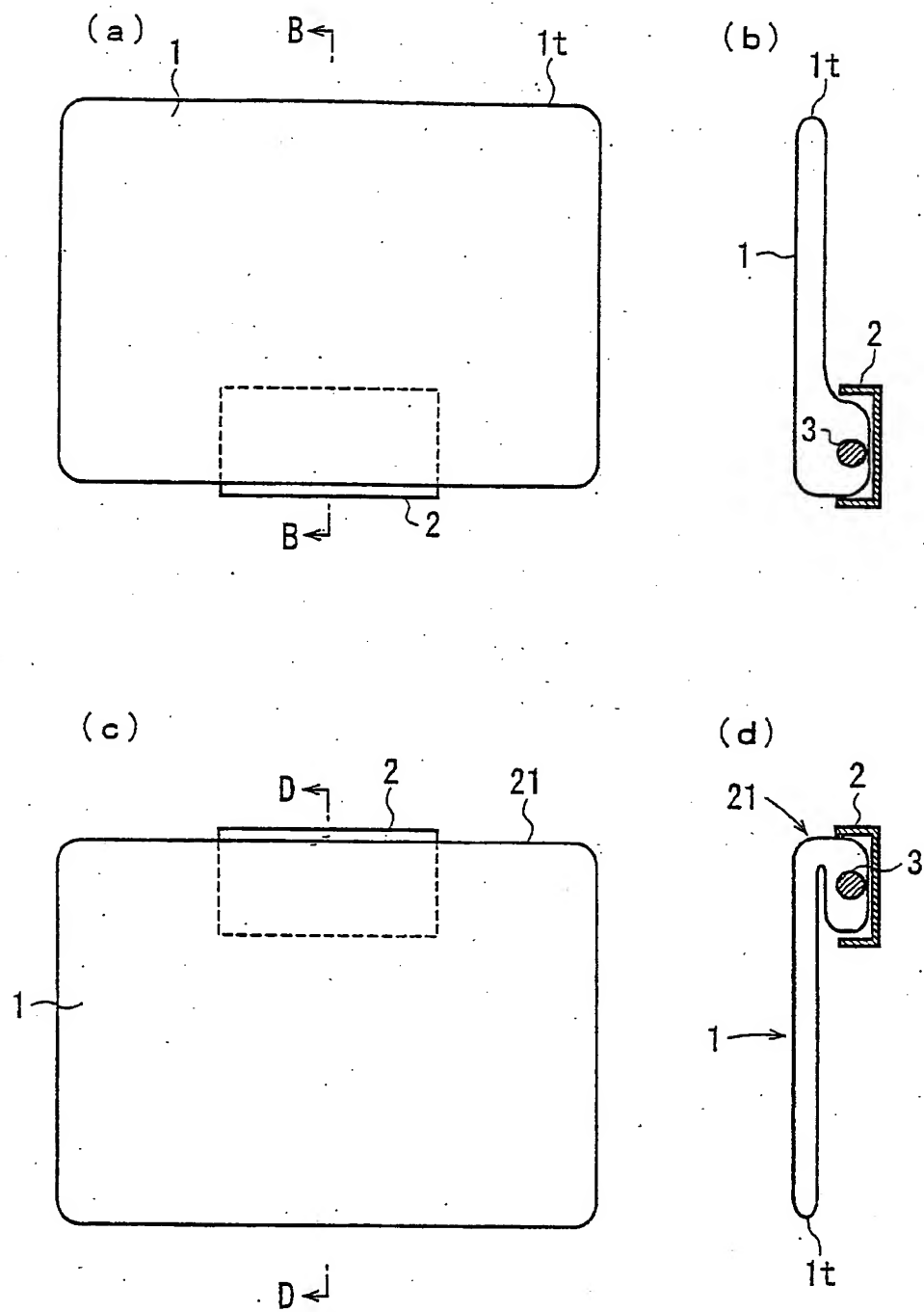


Fig. 8

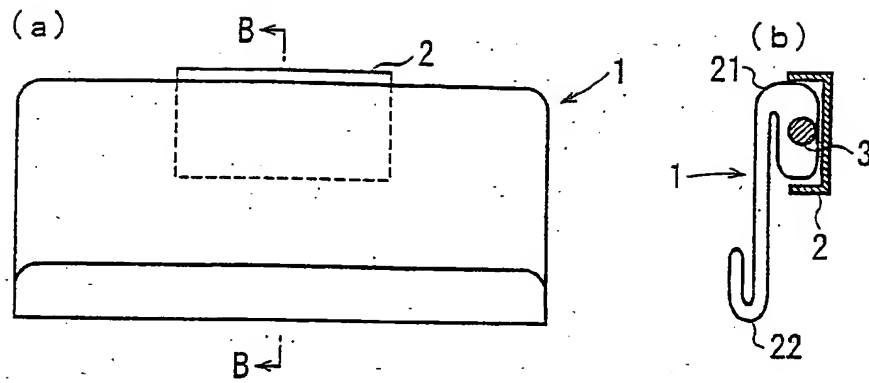


Fig. 9

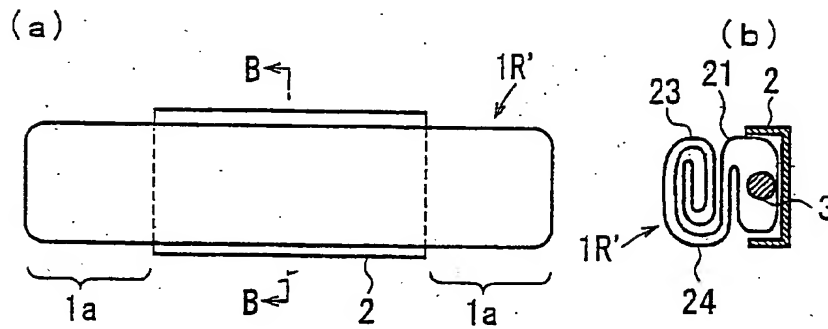


Fig. 10

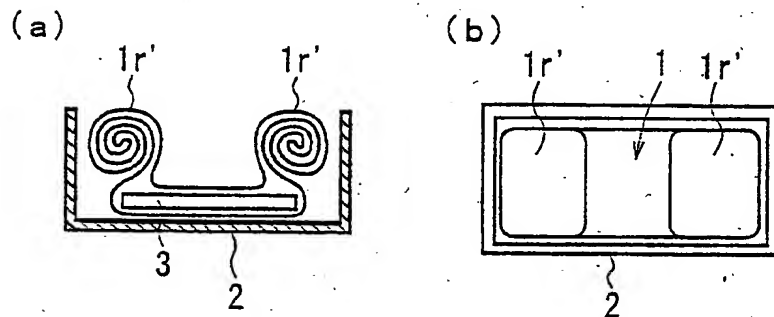


Fig. 11

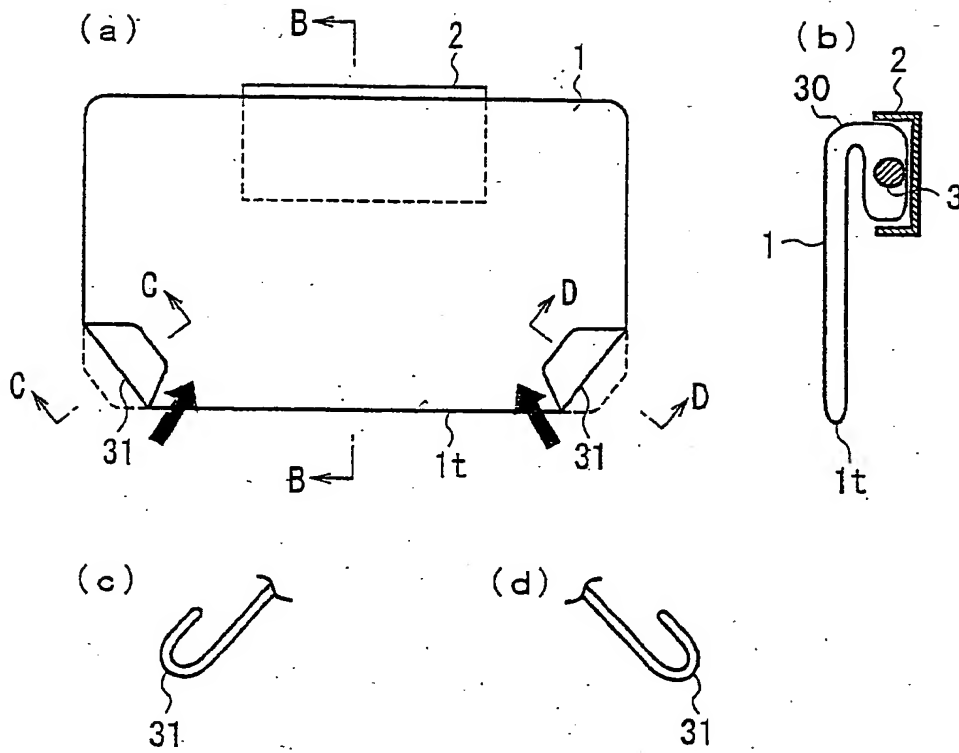


Fig. 12

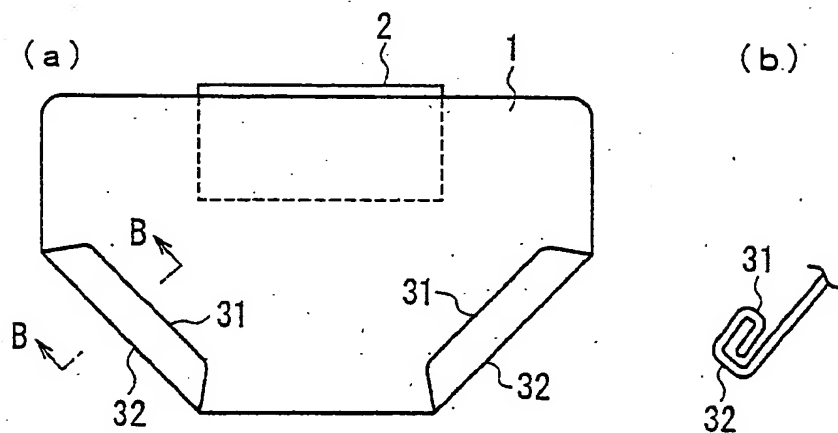


Fig. 13

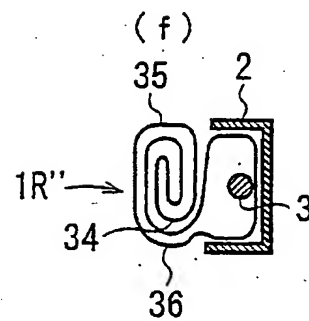
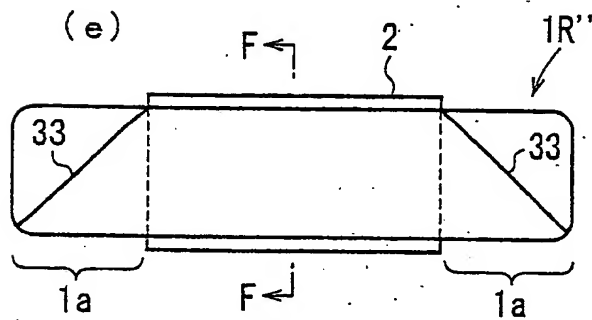
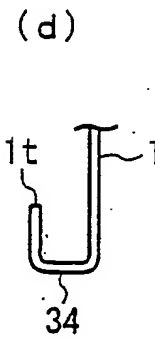
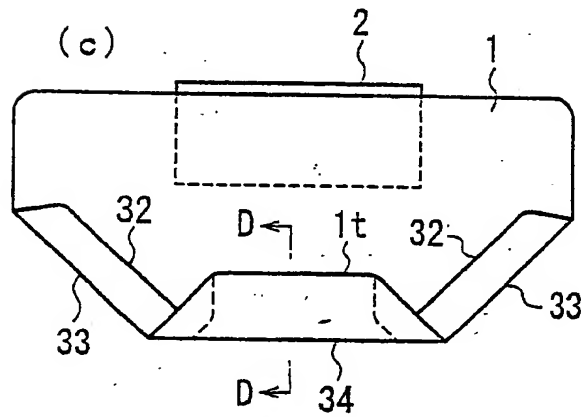
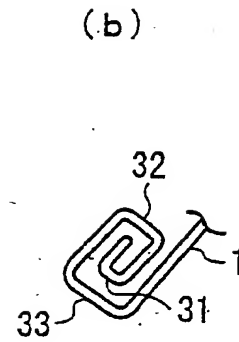
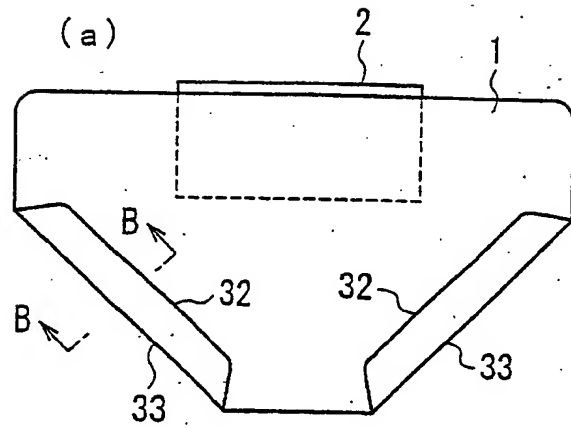


Fig. 14

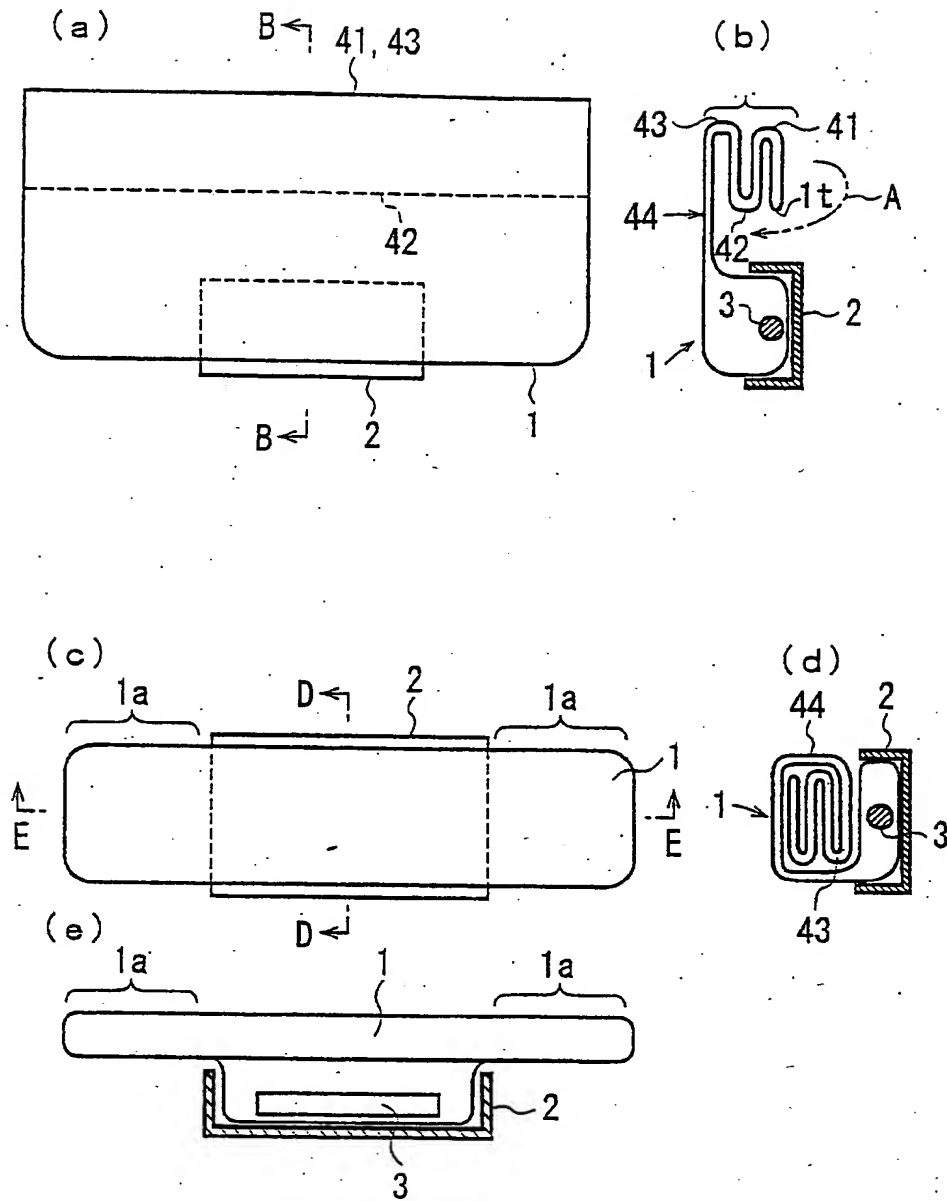


Fig. 15

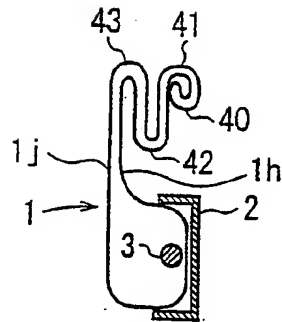


Fig. 16

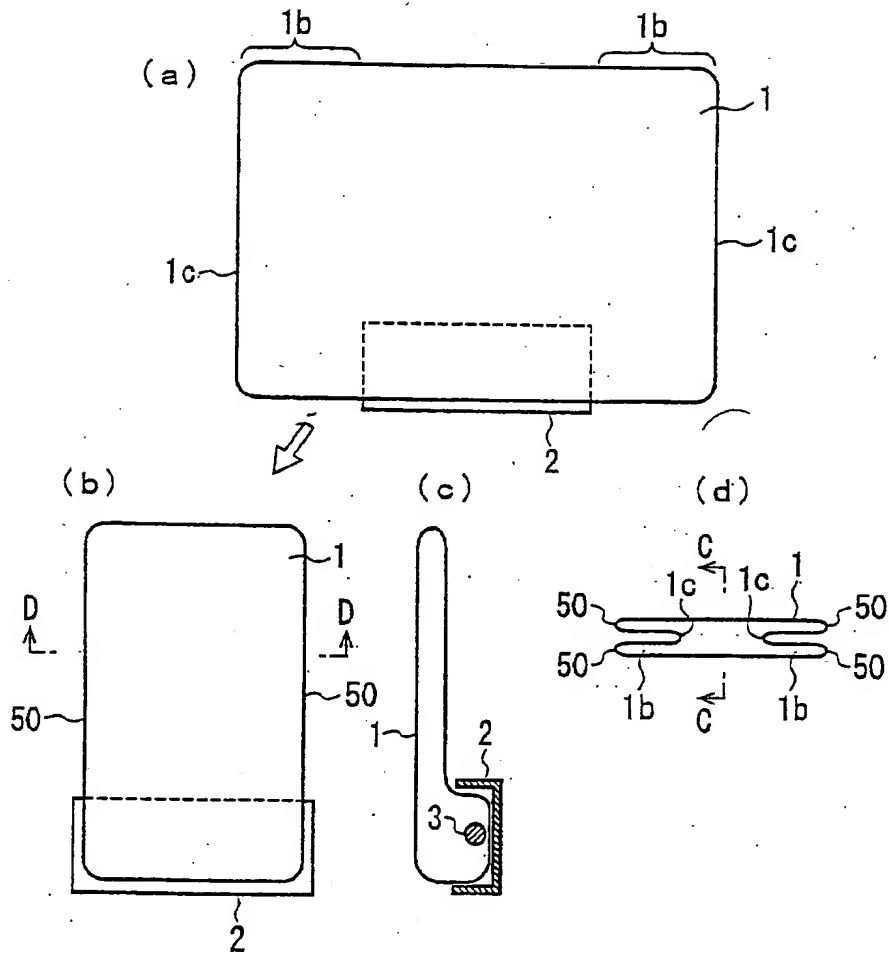


Fig. 17

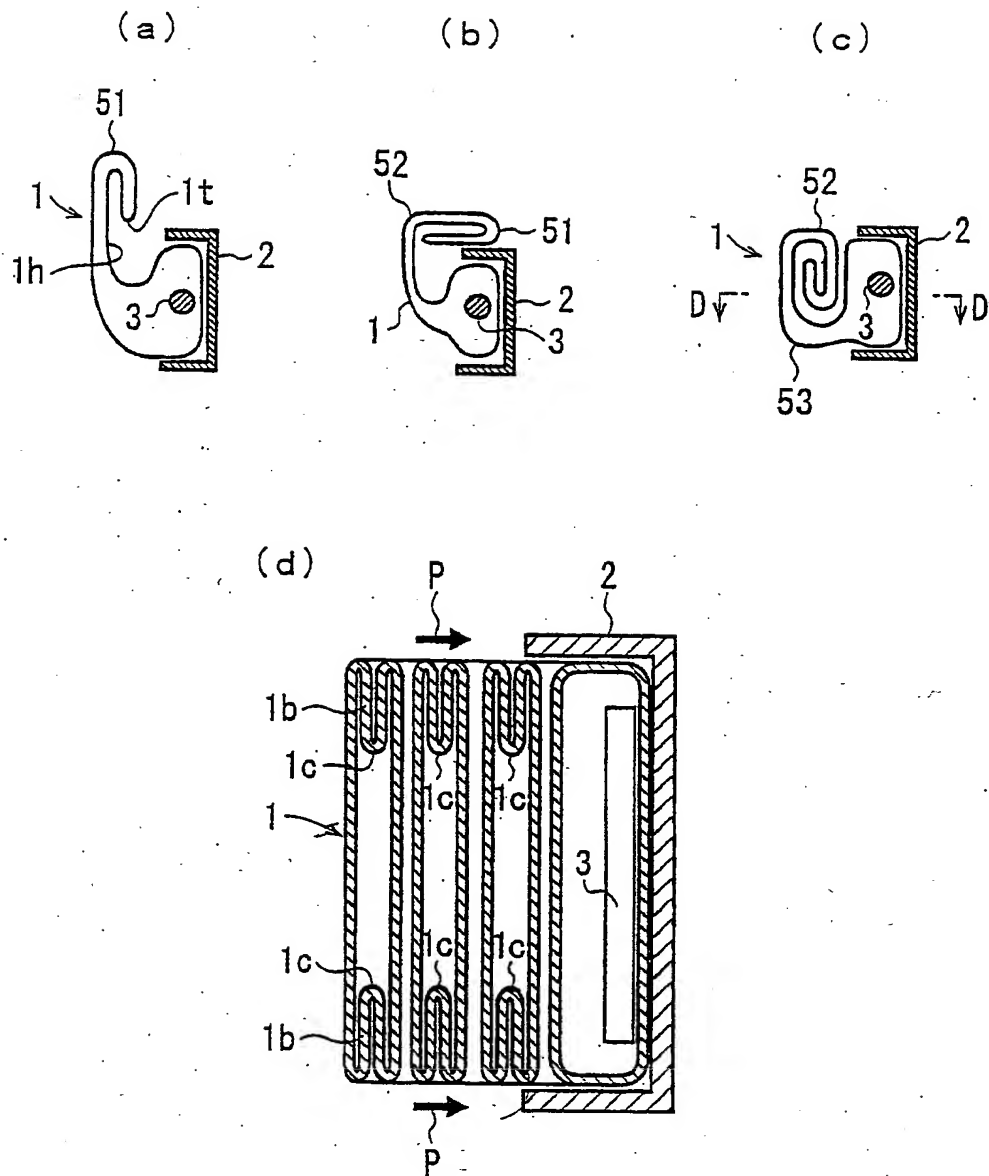


Fig. 18

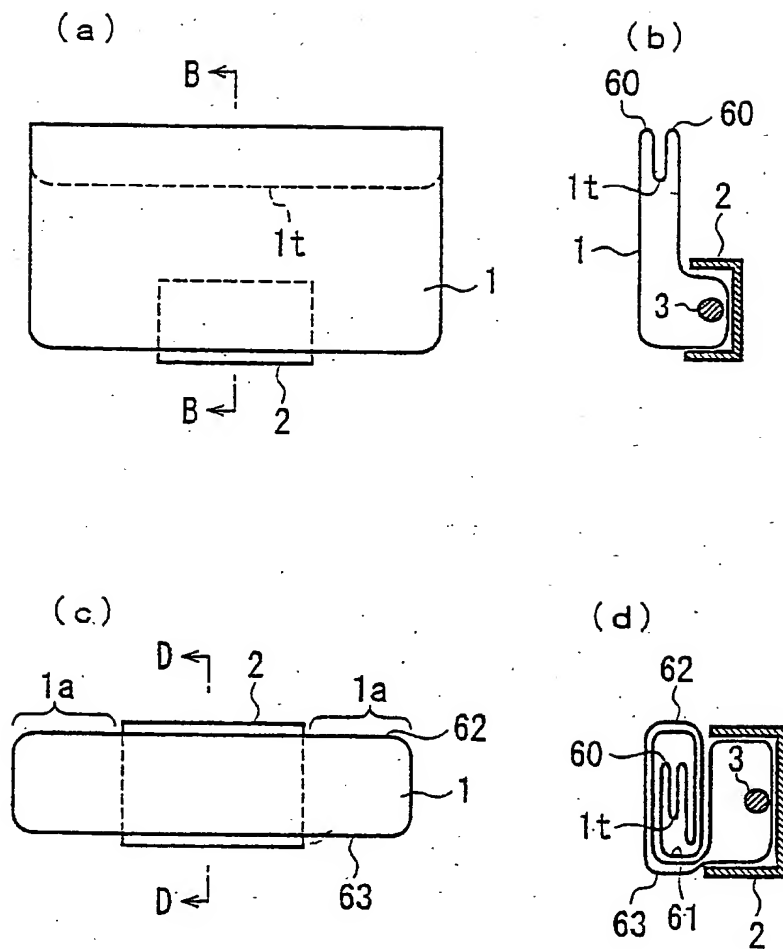
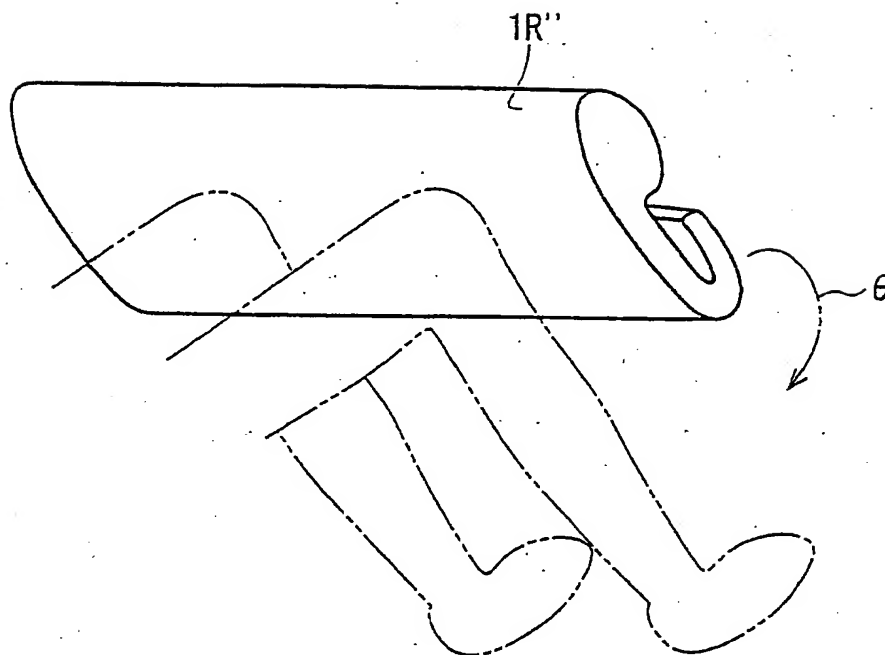


Fig. 19



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